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CHAPTER V.

Anthropometric Analysis

One hundred Santal subjects were measured in the Damin areas, of the Santal Parganas within Chota Nagpur in Bihar. All the specimens chosen were adult males, between the ages of 18 to 49 years.

The technique used throughout for taking the actual measurements was that set up by R. Martin, in his "Lehrbuch der Anthropologie".

The data was analysed and tabulated and is given below.

Measurement or Index :	Mean ± S.E.	S.D. ± S.E.	C. of V ± S.E.
Cephalic Index	74.0 ± 0.52	3.7 ± 0.72	4.3 ± 0.96
Nasal Index	80.7 ± 0.79	7.9 ± 1.77	9.7 ± 2.17
Total Facial Index	85.4 ± 0.42	4.2 ± 0.94	4.8 ± 1.07
Upper Facial Index	53.8 ± 0.37	3.7 ± 0.83	6.8 ± 1.52
Altitudinal Index	70.0 ± 0.56	5.0 ± 1.25	8.0 ± 1.79
Orbito-nasal Index	113.6 ± 0.59	5.9 ± 1.32	5.1 ± 1.14
Rel. Hip Width	16.4 ± 0.11	1.1 ± 0.25	6.7 ± 1.49
Ponderal Index	2.8 ± 0.09	0.89 ± 0.02	3.2 ± 0.72
M. Skelic Index	166.0 ± 0.65	6.5 ± 1.45	6.0 ± 1.34
Radio Humeral Index	72.1 ± 1.01	10.1 ± 2.25	14.0 ± 3.13
Breadth-height Index	103.4 ± 1.15	11.5 ± 2.57	11.1 ± 2.48
Stature	159.3 ± 0.54	5.4 ± 1.21	3.3 ± 0.74
Span	160.0 ± 0.60	6.0 ± 1.34	3.6 ± 0.81
Sitting height	77.1 ± 0.31	3.1 ± 0.69	4.0 ± 0.89
Head length	18.5 ± 0.06	0.6 ± 0.13	3.3 ± 0.72
Head breadth	13.7 ± 0.05	0.5 ± 0.11	3.9 ± 0.85
Head height	12.9 ± 0.10	1.0 ± 0.23	7.7 ± 1.72
Minimum frontal diameter	10.02 ± 0.12	1.2 ± 0.09	12.2 ± 0.87
Nasal height.	4.8 ± 0.04	0.4 ± 0.09	6.2 ± 1.39
Nasal breadth	3.7 ± 0.03	0.3 ± 0.07	5.4 ± 1.21
Upper facial height	7.1 ± 0.05	0.5 ± 0.11	7.0 ± 1.57
Total Facial height	11.3 ± 0.05	0.5 ± 0.10	...
External Orb. Br.	9.9 ± 0.04	0.4 ± 0.09	4.4 ± 0.98
Orbito nasal curve	11.3 ± 0.06	0.6 ± 0.14	4.0 ± 0.89
Bizygomatic breadth	13.0 ± 0.05	0.5 ± 0.10	3.0 ± 0.67
Bigonial diameter	9.2 ± 0.06	0.6 ± 0.13	5.4 ± 1.21

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TABLE I

Stature among Santals

Mean = 150.3±0.54

Minimum = 147.7 cms
Maximum = 173.3 cms.
Range = 25.3 cms.

Frequency Distribution

Stature Class		*Frequency observed*	
V. Short	134.0—135.0 cm.	...	3 PC
	136.0—137.9 cm.	...	
	138.0—139.9 cm.	...	
	140.0—141.9 cm.	...	
	142.0—143.9 cm.	...	
	144.0—145.9 cm.	...	
	146.0—147.9 cm.	1 PC	
	148.0—149.9 cm.	2 ,,	
Short	150.0—151.9 cm.	5 ,,	40 PC
	152.0—153.9 cm.	12 ,,	
	154.0—155.9 cm.	9 ,,	
	156.0—157.9 cm.	11 ,,	
	158.0—159.9 cm.	12 ,,	
Below Medium	160.0—161.9 cm.	16 ,,	27 PC
	162.0—163.9 cm.	11 ,,	
Medium	164.0—165.9 cm.	10 ,,	13 PC
	166.0—166.9 cm.	3 ,,	
Above Medium	167.0—169.9 cm.	6 ,,	6 PC
Tall	170.0—171.9 cm.	...	2 PC
	172.0—173.9 cm.	2 PC	
	174.0—175.9 cm.	...	
	176.0—177.9 cm.	...	
	178.0—179.9 cm.	...	
V. Tall	180.0—X	...	

Stature : With a mean stature of 159.3 cms the Santals can be called "Short" statured according to Martin's classification. The stature however varies

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141 considerably in this sample of the Santals, the shortest specimen being only 147.7 cms, (i.e. Very Short) and the tallest being 173.0 cms (i.e. Tall). The range therefore is 25.3 cms. Fortynine per cent of the subjects measured have a stature below 160.0 cms. (i.e. are short statured) and another 40% are medium and below medium (i.e. below 167.0 cms) Six per cent of the sample are 170 cms; The rest are distributed between the categories of "Very Short" and "Tall". It is interesting to note that not even one specimen was recorded in the "Very Tall" stature group.

TABLE 2.

Cephalic Index

Mean = 74.00±0.33

Min = 66.80.
Max. = 82.80.
Range = 16.00

Frequency Distribution

	C.I. Class	*Frequency observed*	
Dolichocephalic	64.0—64.9	...	
	65.0—65.9	...	
	66.0—66.9	1PC	
	67.0—67.9	...	
	68.0—68.9	4PC	
	69.0—69.9	4 „	75 PC
	70.0—70.9	7 „	
	71.0—71.9	8 „	
	72.0—72.9	18 „	
	73.0—73.9	14 „	
	74.0—74.9	9 „	
	75.0—75.9	16 „	
Mesocephalic	76.0—76.9	4 „	
	77.0—77.9	7 „	
	78.0—78.9	6 „	22 PC
	79.0—79.9	3 „	
	80.0—80.9	2 „	

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	C.I. Class	Frequency observed	
Brachycephalic	81.0–81.9	1 PC	3 PC
	82.0–82.9	2 ,,	
	83.0–83.9	...	
	84.0–84.9	...	
	85.0–85.4	...	
	85.5–X	...	

Cephalic Index: The predominant headform is Dolicocephalic, the mean cephalic Index being 74.00. Of the present samples under study 22% are Mesocephalic and only 3% are Brachycephalic. The range of the cephalic index varies from 66.8 to 82.8 (i.e. the difference between the maximum and minimum values encountered is 16.0).

TABLE 3.

Nasal Index

Mean = 80.7 ± 0.79

Min. = 62.70
Max. = 95.00
Range = 32.30

Frequency Distribution.

	N.I. Class	Frequency observed	
Leptorrhine	52.0–54.9	...	13 PC
	55.0–57.9	...	
	58.0–60.9	...	
	61.0–63.9	4.0 PC	
	64.0–66.9	1.0 ,,	
	67.0–69.9	8.0 ,,	
Mesorrhine	70.0–72.9	12.0 ,,	66 PC
	73.0–75.9	17.0 ,,	
	76.0–78.9	21.0 ,,	
	79.0–81.9	6.0 ,,	
	82.0–84.9	10.0 ,,	

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	N.I. Class	*Frequency observed*	
Platyrrhine	85.0—87.9	9.0 PC	21 PC
	88.0—90.9	7.0 ,,	
	91.0—93.9	4.0 ,,	
	94.0—96.9	1.0 ,,	
	97.0—99.9	...	
	100.0—X	...	

Nasal Index: Sixty-six per cent of the Santals included in this sample exhibit Mesorrhine i.e. their nasal index falls within the frequency of 70.0 to 84.9. The mean value of the Nasal Index of the sample is 80.7. Platyrrhine members form 21% of the sample, and 13% of the Santals are Leptorrhine. The range of variation of the Nasal Index is 62.7 to 95.0 *i.e.* 32.3

TABLE 4.

BREAD-HEIGHT-INDEX

Mean = 103.40 ± 1.15

Min. = 76.10
Max. = 114.90
Range = 38.80

Frequency distribution

Br. Height Index Class.		*Frequency observed*	
Tapeino	71.0— 72.9	...	3PC
Cephalic	73.0— 74.0	...	
	75.0— 76.9	2PC	
	77.0— 78.9	1 ,,	
Metrio	79.0— 80.9	1 ,,	9PC
Cephalic	81.0— 82.9	5 ,,	
	83.0— 84.9	3 ,,	
Acro	85.0— 86.9	6 ,,	88 PC
Cephalic	87.0— 88.9	3 ,,	
	89.0— 90.9	7 ,,	
	91.0— 92.9	11 ,,	
	93.0— 94.9	19 ,,	
	95.0— 96.9	14 ,,	
	97.0— 98.9	18 ,,	
	99.0—100.9	6 ,,	

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Br. Height Index Class		*Frequency observed*	
Acro Cephalic	101.0—102.9	7 PC	
	103.0—104.9	1 „	
	105.0—106.9	2 „	
	107.0—108.9	4 „	
	109.0—110.9	1 „	
	111.0—112.9	...	88 PC
	113.0—114.9	1 „	
	115.0—116.9	...	
	117.0—118.9	1 „	
	119.0—120.9	...	

Breadth-height Index : The mean value of this Index is 103.4, consequently the individuals included in this sample possess crania whose height is greater than its breadth by 1.03 times. The minimum value of this index, recorded for these people is 76.1, and the maximum value is 114.9, and from this we can observe a statistically significant range of variation of 38.8.

TABLE 5

Altitudinal Index

Mean = 70.00 ± 0.36

Min. = 53.50
Max. = 82.30
Range = 28.80

Frequency distribution

Alt. Index Class.		*Frequency observed.*	
Chamaecephalic	40.0—41.9	...	
	42.0—43.9	...	
	44.0—45.9	...	
	46.0—47.9	...	
	48.0—49.9	...	2 PC
	50.0—51.9	...	
	52.0—53.9	1 PC	
	54.0—55.9	...	
	56.0—57.6	1 PC	

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Alt. Index Class		Frequency observed	
Orthocephalic	57.7—59.5	1 PC	8 PC
	59.7—61.5	4 ..	
	61.7—62.5	1 ..	
Hypsicephalic	62.6—64.5	6 ..	90 PC
	64.6—66.5	7 ..	
	66.6—68.5	13 ..	
	68.6—70.5	14 ..	
	70.6—72.5	18 ..	
	72.6—74.5	12 ..	
	74.6—76.5	5 ..	
	76.6—78.5	9 ..	
	78.6—80.5	4 ..	
	80.6—82.5	2 ..	
	82.6—84.5	...	
	84.6—86.5	...	
	86.6—X		

Altitudinal Index: On the average the height of cranium, of the Santal, (head height) is 70% of his maximum head length. Thus the average Santal is Hypsicephalic. Ninety per cent. of the subjects measured show an altitudinal index valued at 62.5% or over. The range of the variation is high, standing at 28.8 units. Eight per cent. of the sample is Orthocephalic and only 2% exhibit Chamaecephaly.

TABLE 6.

Total Facial Index

Mean = 85.8 ± 0.42

Min. = 76.50
Max. = 99.20
Range = 22.70

Frequency Distribution

Total Facial Index Class		Frequency observed
Euryprosopic	70.0—70.9	...
	71.0—71.9	...

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Total Facial Index Class		Frequency Observed	
	72.0—72.9	...	
	73.0—73.9	...	
	74.0—74.9	...	
	75.0—75.9	...	
	76.0—76.9	2 PC	
	77.0—77.9	1 „	34 PC
	78.0—78.9	...	
	79.0—79.9	2 PC	
	80.0—80.9	2 „	
	81.0—81.9	7 „	
	82.0—82.9	12 „	
	83.0—83.9	8 „	
Mesoprosopic	84.0—85.9	14 „	30 PC
	86.0—87.9	16 „	
Leptoprosopic	88.0—88.9	13 „	
	89.0—89.9	6 „	
	90.0—90.9	4 „	32 PC
	91.0—91.9	5 „	
	92.0—92.9	4 „	
Hyper-lepto-	93.0—93.9	1 „	
prosopic.	94.0—94.9	...	
	95.0—95.9	1 PC	
	96.0—96.9	1 „	4 PC
	97.0—97.9	...	
	98.0—98.9	...	
	99.0—99.9	1 PC	
	100.0—X	...	

Total Facial Index: The mean value for the Index is 85 8, i.e. Mesoprosopic, and the index varies between

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141 the maximum and minimum limits of 76.5. to 99.2 Thirty-six per cent of the sample is Leptoprosopic, 34% are Euryprosopic, and 30% are Mesoprosopic.

TABLE 7

Upper Facial Index

Mean = 53.80 ± 0.37

Min. = 45.4
Max. = 75.6
Range = 30.2

Frequency Distribution

Upper Facial Index Class		*Frequency Observed*	
Hyper-Euryene	40.0—40.9	...	
	41.0—41.9	...	
	42.0—42.9	...	
Euryene ^1	43.0—43.9	...	
	44.0—44.9	1 PC	4 PC
	45.0—45.9	...	
	46.0—4.69	...	
	47.0—47.9	3 PC	
Mesene	48.0—48.9	3 ,,	
	49.0—49.9	4 ,,	
	50.0—50.9	11 ,,	31 PC
	51.0—51.9	6 ,,	
	52.0—52.9	8 ,,	
Leptene	53.0—53.9	15 ,,	
	54.0—54.9	14 ,,	49 PC
	55.0—55.9	12 ,,	
	56.0—56.9	8 ,,	
Hyper-Leptene	57.0—57.9	7 ,,	
	58.0—58.9	3 ,,	
	59.0—59.9	3 ,,	15 PC
	60.0—60.9	...	
	61.0—61.9	...	
	62.0—62.9	...	

1 [Erratum: this should read "Euryene." Cf. errata sheet, category 116, p. ix -- Analyst]

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Upper Facial Index Class.		*Observed Frequency*	
Hyper-Leptene	63.0 63.9	...	141
	64.0—64.9	...	
	65.0—65.9	1 PC	
	66.0—66.9	...	
	67.0—67.9	...	
	68.0—68.9	...	15 PC
	69.0—69.9	...	
	70.0 - 70.9	...	
	71.0—71.9	...	
	72.0—72.9	...	
	73.0—73.9	...	
	74.0—74.9	1 PC	
	75.0—75.9	...	

Upper Facial Index: The mean value of this index is 53.8, i.e. on an average the Santals belong to the Leptene category and possesses[1] a moderate facial appearance. Thirty two per cent. of the sample belong to this category 49% of them are Leptene, 4% are Euryene. Hyperleptene faces also occur in 15% of the population.

TABLE 8.

Orbito-Nasal Index among Santals.

Mean = 113.6 ± 0.59

Minimum = 101.00
Maximum = 144.30
Range = 43.30

Frequency Distribution

Orbito-Nasal Index Class		*Frequency Observed*	
Platyopic	100.0—101.9	1 PC	
	102.0—103.9	4 ,,	
	104.0—105.9	7 ,,	21 PC
	106.0—107.9	4 ,,	
	108.0—109.9	5 ,,	
Mesopic	110.0—110.9	8 ,,	83 PC
	111.0—112.9	15 ,,	

[1] [Erratum: this should read "possess." Cf. errata sheet, category 116, p. ix -- Analyst]

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Orbito-Nasal Index Class		Frequency Observed.	
Pro-opic.	113.0—114.9	12 PC	
	115.0—116.9	12 ,,	
	117.0—118.9	17 ,,	
	119.0—120.9	5 ,,	
	121.0—122.9	7 ,,	
	123.0—124.9	2 ,,	
	125.0—126.9	...	
	127.0—128.9	...	
	129.0—130.9	...	
	131.0—132.9	...	
	133.0—134.9	...	56 PC
	135.0—136.9	..	
	137.0—138.9	...	
	139.0—140.9	...	
	141.0—142.9	...	
	143.0—144.9	1 PC	
	145.0—146.9	...	
	147.0—148.9	...	
	149.0—150.9	...	
	151.0—X.		

Orbito-nasal Index: The norm for this characteristic is 113.6 i.e. Pro-opic. The range of variation is 101.0—144.3=43.3 Fifty six per cent. of the Santals have an index of 112.9 or more which means they are Pro-opic, 21% are Platyopic and the rest are Mesopic. So, though Pro-opic individuals are most common, Platyopic or Mesopic groups are not far behind.

Radio Humeral Index: This is a relation of the upper arm to the forearm. Its value has been calculated for 20 Santal subjects only, and the values observed show that the Santal bears a short forearm in relation to his upper arm.

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TABLE 9.

Span.

Mean=166.0±0.06

Minimum=150.8
Maximum=187.4
Range = 37.8

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Frequency Distribution

Span Class	*Observed Frequency.*
140.0—142.5	...
142.6—145.0	...
145.1—147.5	...
147.6—150.0	...
150.1—152.5	2.0 PC
152.6—155.0	2.0 „
155.1—157.5	5.0 „
157.6—160.0	5.0 „
160.1—162.5	13.0 „
162.6—165.0	14.0 „
165.1—167.5	18.0 „
167.6—170.0	17.0 „
170.1—172.5	9.0 PC
172.6—175.0	7.0 „
175.1—177.5	5.0 „
177.6—180.0	2.0 „
180.1—182.5	...
182.6—185.0	...
185.1—187.5	1 PC
187.6—190.0	...
190.1—192.5	...
192.6—195.0	...
195.1—197.5	...
197.6—200.0	...
200.1—X	...

Span: The Santals of this sample display on an average a "Span" of 166.0 cms. exhibiting thereby a larger span than stature. The index of span to stature varies from 101.7 to 107.2, that is, the range of

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141 variation is equal to 5.5 Here even the lowest value gives an index which indicates that the span is slightly more than the Stature.

TABLE 10.

Relative Hip Width.

Mean=16.4

Minimum=13.8
Maximum=19.6
Range = 5.8

Frequency distribution.

Relative Hip Width	*Frequency observed*
10.0—10.9	...
11.0—11.9	...
12.0—12.9	...
13.0—13.9	2 PC
14.0—14.9	13 ,,
15.0—15.9	14 ,,
16.0—16.9	37 ,,
17.0—17.9	26 ,,
18.0—18.9	7 ,,
19.0—19.9	1 ,,
20.0—20.9	...
21.0—X	...

Relative Hip Width: The mean index is 16.4 indicating that the average Santal displays a Hip Width which is approximately 1/6 of his Stature. The range of variation is 13.8 to 19.6; i.e. 5.8. The minimum value is shown by a specimen whose hip is approximately 1/7 of his Stature.

TABLE 11.

Ponderal Index

Mean=2.8±0.11

Minimum=2.6
Maximum=3.1
Range =0.5

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Frequency Distribution

Ponderal Index.	*Observed frequency*
2.0—2.1	...
2.2—2.3	...
2.4—2.5	...
2.6—2.7	18.0 PC
2.8—2.9	75.0 „
3.0—3.1	7.0 „
3.2—3.3	...
3.4—3.5	...
3.6—3.7	...
3.8—3.9	...
4.0—X	...

Ponderal Index : This index determines the relationship between the weight and the height of an individual. Its value fluctuates between the limits 2.6 and 3.1 and the mean stands at 2.8. Twenty-four percent of the Santals measured, show an increase in weight with an increasing stature.

TABLE 12.

Manouvre Skelic Index

Mean = 106.60 ± 0.65

Minimum = 88.00
Maximum = 122.50
Range = 34.5

Frequency Distribution of Manouvre Skelic Index among Santals

M. Skelic Index Class		*Frequency Observed*
Hyper-Mesati—Skelic	1—84.9	...
Mesati—Skelic	85.0—86.9	...
	87.0—88.9	1 PC
	89.0—90.0	...
Sub-Makro-Skelic	90.1—92.0	1 PC
	92.1—94.0	1 „
	94.1—95.0	1 „

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Makro-Skelic	95.1 – 97.0	3 PC
	97.1—99.0	4 ,,
	99.1 – 100.0	4 ,,
Hyper-Makro-Skelic	100.1 – 102.0	7 ,,
	102.1 – 104.0	13 ,,
	104.1 – 106.0	7 ,,
	106.1 – 108.0	16 ,,
	108.1—110.0	12 ,,
	110.1—112.0	10 ,,
	112.1—114.0	9 ,,
	114.1—116.0	2 ,,
	116.1 – 118.0	6 ,,
	118.1—120 0	1 ,,
	120.1—122.0	...
	122.1 – 124.0	2 PC
	124.1—X	...

Menouvres Skelic Index :—An indication of the relationship between trunk length and leg length, the mean value of this index stands at a figure above 100.00, i.e. 106.6 which means that on an average a Santal measures more on the lower limbs, than what his trunk length records.

This range of variation shown by the index is very wide, i.e. from 88.0—122.5—34.5. In 5% of cases, the trunk length is definitely greater. Eleven percent of the Santal subjects exhibit Macro-skely, i.e. the Menouvres Skelic Index is within the limits (95.1 to 100.0). Out of these Macro-skelics only one bears the value 100.00 of the Index, meaning thereby that the upper and lower limbs are of an equal length. The rest of the Mackro-Skelics share in common the character of a greater trunk length, at the expense of smaller legs, though the relation of two lengths at the greatest value is 20 : 19 respectively, Eighty-four percent (or clear

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majority) of the subjects have longer legs that support smaller trunks in comparison i.e. they are Hyper-Mackro-Skelic. |41

Comparison of Stature, Cephalic Index and Nasal Index

When Stature, Cephalic Index and Nasal Index are compared it is observed that the greatest concentration of the Santal Cephalic Index is at 76%, which 75% of the subjects possess. Of these 5% have medium noses, of whom 42% are short statured, 4% have a medium stature, 2% are above medium, and 2% are tall. Sixteen percent have flat noses (Platyrrhine), of which 11 are short statured, 3% are of medium stature, and 2% have an Above Medium Stature. Under the Leptorrhine group come 9% individuals of whom 7% possess short stature, 1 is Medium Stature, and the remaining individual of Above Medium Stature.

Twenty-two percent of the sample are grouped under the C. I. frequency[1] of 76.1 to 80.9; of these 14% show Mesorrhinii, and of them 10 are short statured, 4% have Medium stature and the remaining 8 subjects show platyrrhinii and leptorrhinii, in the ratio of 7 : 1. The 7 are short statured and the last man is of medium stature.

Brachycephaly is rare and only 3% fall in this frequency of the Cephalic Index. All are of short stature, two are leptorrhine, and one Mesorrhine.

Therefore taking a birdseye view of the population we see that the majority of the Santals combine dolicocephaly, with short stature and short to medium stature.

1 [Erratum: this should read "frequency." Cf. errata sheet, category 116, p. ix -- Analyst]

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141 Thus we see that 46% of the Santal males investigated, possess the somatic characters, short-medium stature; Dolicocephaly; and Mesorrhine; characters which Haddon would term a blend between the Dravidian and Pre-Dravidian strains. Fourteen percent of the sample is Short-Medium statured, Dolicocephalic, and Platyrrhine, characteristics of the Pre-Dravidian according Haddon and his followers. The typically Dravidian type, of Short-Medium stature, Dolicocephalic, and leptorrhine, number 8%. There is an intermixture of the Pre-Dravidian and Dravidian elements, on the one hand, and an Alpine or Pamirian element on the other, among 14%, who show Short-Medium stature, show Mesocephaly and are Mesorrhine.

142 **Santals: (A Study in Somatoscopic Characters).**

Skin Colour:—The unexposed skin varies in colour from light brown (17) to dark brown (26)*. Ninety-eight percent of the Santals are dark-brown, and a negligible 2% are light brown.

Hair Form:—Low waves occur in 84% of the Santals surveyed, and 8% have straight hair. The remaining 8% can be accounted for, by curly, deep waves, and medium wave forms in the proportion of 5 : 2 : 1. Wooly hair is conspicuous by its absence.

Hair Texture:—Hair of medium texture occurs in 81% of the people, and there are 16% of the sample with coarse hair. Fine textured hair is rare and occurs among only 3%.

*The numbers in parenthesis indicate the colours on the skin chart devised by Von Luschan.

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Incisor fold :—Only 1% showed a slight incisor fold. 142

Body :—Seventy four per cent had bodies of medium musculature, and 14% were weakly built. The remaining 12%, were markedly well built.

Santal (Correlation).

Table showing co-efficients of co-relation with Probable Errors 141

1. Head Length and Head Breadth :—0 0016±0.067
2. Nasal height and Nasal Breadth :—0.29+0.061
3. Total facial height and Bizygomatic Breadth :—0.61+0 042
4. Upper facial height and Bizygomatic breadth :—0.26+0.062
5. Head length and Head height : −0.18+0,064
6. Head breadth and Head height :—0.28+0.061
7. External Orbital breadth and Orbito-nasal curves :—0.75+0.029
8. Height vertex and Maximum Hip Breadth :—0.24+0.063

1. *Head Length and head breadth* :—There has been found to be, after tabulation and calculation, very little (insignificant) positive correlation between the variables 'Head Length' and 'Head Breadth' in the case of this sample. No doubt, on an average, the increase in the Head Length of a Santal individual is accompained by a corresponding increase in his Head Breadth yet the co-efficient of correlation (0.0016) is of no standing.

2. *Nasal Height and Nasal Breadth* :—These measurements are of great significance from the somatometric point of view, for they enable us to evaluate

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141 Nasal Index, which is one of the chief criteria for the determination of racial affinities. My Santal subjects have an ascending value of these variables, i.e. a positive correlation has been found to exist in their case. The actual value of the coefficient of correlation between the Nasal Height and Nasal Breadth stands at 0.29, a figure which in terms of Biometry means a small correlation, though it cannot be called insignificant.

3. *Total Facial Height and Bizygomatic Breadth* :— A high degree of positive correlation has been found in the case of these variables. The actual value of the co efficient stands at 0.61 (i.e. above 0.50) which denotes a fair amount of correlation.

4. *Upper Facial Height and Bizygomatic Breadth*:— A moderate degree of correlation, of a positive character exists between the upper Facial Height and the Bizygomatic Breadth of the Santals that have been subjected to investigation. The co-efficient has been evaluated at 0.26.

5. *Head Length and Head Height*:—On an average the head length of a man from Santal Parganas increases with his Head Height and vice versa. No case has been recorded which might suggest an exception to the rule. The co-efficient of correlation which determines the rate of increase in one variable due to an increase in the other has been calculated as 0.18.

6. *Head Breadth and Head Height* :—By comparison with the variables considered in the previous paragraph a greater amount of correlation and that too, in a positive direction has been recorded in the present

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case. The coefficient of correlation that has been arrived at, amounts to 0.28. 141

7. *External Orbital Breadth and Orbito Nasal Curve* : These anthropometric measurements reveal a direct mutual dependence, for they have been found in possession of a value of the co-efficient of correlation which stands exactly midway between the value representing a fair degree of correlation (0.50) and complete harmony or correlation (1.00). The title of substantive correlation may be assigned to the value of the co-efficient (0.75) that we get in this case.

8. *Height Vertex and Maximum Width*—Once again, we get a positive correlation between the two variables under consideration, the actual co-efficient standing at 0.24.

The co-efficient of mean square contingency*. "Prof. Karl Pearson's coefficient of mean square contingency permits the measurement on a scale from zero to unity of the degree of association of pairs of attributes, without any assumption as to their continuous distribution in a scale variation and irrespective of the order in which these pairs of attributes occur. Thus, if it is desired to measure the association between hair colour and eye colour or between type of offense and hair colour, such a co-efficient is most useful. What the co-efficient of mean square contingency actually measures is the degree to which the various combinations of pairs of attributes depart from a purely chance distribution or from independence. According to the law of probability if the frequency of A_m's be denoted by (A_m) and the 128 141

*The American Criminal, E A. Hooton. p. 53.

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•141 frequency of B_n's by (B_n), and the frequency of objects or individuals possessing both characters $(A_m B_n)$, then if A's and B's be completely independent in the universe at large $(A_m B_n) = \frac{(A_m)(B_n)}{N} = (A_m B_n)_0$. In other words the expected Frequency of combination of pairs of attributes is equal to the product of the total number of frequencies of attributes A in the series and the total number of frequencies of attribute B in the series divided by N (the total number of observations of the series). $(A_m B_n)_0$ may be called the INDEPENDENCE FREQUENCY. The coefficient of mean square contingency is based upon the difference between the expected or independence frequencies and the actual frequencies. However, since some of the differences are minus and some are plus, a mere addition might cancel them out. Therefore, in order to obviate the difficulty the differences are squared and expressed as a ratio of the expected frequencies. Thus we have

$$\Sigma \left(\frac{(A_m B_n) - (A_m B_n)_0}{(A_m B_n)_0} \right)^2$$

and by reduction, since the sum of both the (AB)'s and the $(AB)_0$'s is equal to the total number of observations, N:

$$\Sigma \left(\frac{(A_m B_n)^2}{(A_m B_n)_0} \right) - N$$

The expression in brackets is then the sum of the squares of the actual frequencies of the pairs of attributes divided by their expected (independence) frequencies. If this expression be denoted by S, we have for C, the coefficient of mean square contingency, $C = \sqrt{\frac{S-N}{S}}$. This coefficient expresses on a scale

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between zero and unity the extent to which the pairs of attributes in their actual combinations depart from chance expectation."

"The coefficient of Mean Square cotingency can be zero only when there is no deviation from the Independent[1] Frequency in any compartment of the table. Such a condition cannot be realized in limited samples and consequently the coefficient is more than zero in any case. In other words, some part of the value of the coefficient is attributable to the sampling process. A correction for this may be introduced, but this is hardly necessary if the coefficient is interpreted with caution. In any extent, the coefficient indicates nothing more than the extent to which the associations of the two attributes depart from independence."

1. Association between the hair colour and eye colour of Santals.

As seen before in a study of physical observation the majority of our subjects have black hair (94.0 p.c) and the eye colour is dark-brown (corresponding to No. 3 of Martin's eye-chart, in 89.0 percent instances.

(i) The number of individuls with black colour of hair but without the eyes of dark brown colour $=12$ *i.e.* A_a in the Formula $=12$.

(ii) The number of individuals having dark-brown eyes, but not black hair, *i.e.* $B_b = 6$.

(iii) The number of individuals, in whom both the attributes (*i.e.* black hair and dark brown eyes) are present $=82$. *i.e.* (A_aB_b) in the formula $=82$.

1 [Erratum: this should read "independence." Cf. errata sheet, category 116, p. ix -- Analyst]

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141 Therefore Expected Frequency $(A_\alpha B_\alpha)_0$ can be found out by the application of the relation $(A_\alpha B_\alpha)_0 = \frac{(A_\alpha)(B_\alpha)}{N}$. Hence $(A_\alpha B_\alpha) = \frac{12 \times 6}{100} = 0.72$.

C, the coefficient of Mean square contingency $= \sqrt{\frac{S-N}{S}}$ where S=sum of the squares of the actual frequencies of the pairs of attributes, + Independence frequencies. From our data $S = \frac{(12)^2+(6)^2}{0.72} = \frac{180}{0.72} = 250$

$$\therefore C = \sqrt{\frac{250-100}{250}} = \sqrt{\frac{15}{25}} = \frac{3.8}{5} = 0.76$$

Thus we find that the coefficient of Mean Square contingency which determines the association between the Hair Colour and Eye Colour of our Santal subjects is 0.76 (below unity). In other words the pairs of attributes under consideration (Hair Colour and Eye colour) in actual combinations depart from chance expectation to a considerable extent.

128 **2. Association between the skin colour and eye colour of Santals:**

141 We have already noted under physical observations
142 that a clear majority of Santals show a dark brown colour on the skin as well as in their eyes. The former class is represented by 98.0 percent individuals, and 89.0 percent individuals can be included in the latter classification.

It is further brought out that there are only ten individuals in a total of hundred whom we have studied, who have dark brown skins alright but without dark
128 eyes. On the other hand not a single individual exists
141 having eyes of a dark-brown colour, without the skin tinted with the corresponding colour. So that in the

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mathematical relation that enables us to arrive at the expected or independent frequency $(A_\alpha B_\alpha)_0$. Am = 10 and B_α = 0.

FORMULA—Independent Frequency = $\frac{(A_\alpha)\ (B_\alpha)}{N}$, where N in the denominator represents the number of individuals examined for the pair of attributes under investigation.

Hence we get on the actual application of the values, the value of $(A_\alpha B_\alpha)_0$ or Independent Frequency = $\frac{(10\ (\text{Zero})}{100}$ = 0 Actual counting reveals that both the attributes (A_α and B_α) are present in no less than ninety (90) individuals, i.e. $(A_\alpha B_\alpha)$ = 90.

Now, in order to find out the coefficient of mean of the actual frequencies of the pairs of attributes square contingency, we must know S; S stands for the sum of the squares divided by Independence Frequencies. S, according to our data $\frac{(10)^2+(0)^2}{0} = \frac{100}{\text{Zero}}$ = (Infinite) Therefore C or the coefficient of Mean Square contingency = $\sqrt{\frac{S-N}{S}}$ = $\sqrt{\frac{\infty-100}{\infty}}$ = ZERO

The zero value of the coefficient implies that there is no deviation from the Independent Frequency, a condition which is a rare occurrence in limited samples.

3. Association between colour of skin and hair colour of Santals.

While studying the physical features of Santals, we noted that a majority of them (94.0 p.c. have black hair and that in a greater majority still (98.0 p.c.) they possess skins of dark-brown colour.

[Errata: these should read "independence." Cf. errata sheet, category 116, p. ix - Analyst]

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It has been further noted that six percent individuals show a dark-brown skin colour, but not the presence of black hair. They can be represented by A_m in the formula to find out the Independence Frequency. Those who show vice versa features i.e. (black hair minus Dark-Brown Skin) are accounted by 38 in a total of hundred (N=100). We can call them by the symbol B_n in the formula for Independnce Frequency. The remaining individuals, who constitute fifty six percent of the aggregate possessed both attributes (B_m B_n).

Independence Freguency[1] $(A_m B_n)_0 = \frac{(A_m B_n)}{N} = \frac{6 \times 38}{100} = 2.28$

The coefficient of Mean Square contingency, C=

$\sqrt{\frac{S-N}{S}}$, where S and N have their usual meanings.

S according to our data $= \frac{(A_m)^2 + (B_n)^2}{(A_m B_n)_0} = \frac{(6)^2 + (38)^2}{2.28}$

$$= \frac{1480}{2.28} = 649.1$$

$$\therefore \quad C = \sqrt{\frac{S-N}{S}} = \sqrt{\frac{649.1 - 100}{649.1}} = \sqrt{\frac{549.1}{649.1}}$$

$$= \frac{23.4}{25.4} = 0.9$$

The numerical value of the coefficient of Mean Square contingency in this case can be interpreted as drifting in a remarkable measure from chance expectation of the attributes (skin colour and hair colour) when seen in actual combinations.

1 [Erratum: this should read "frequency." Cf. errata sheet, category 116, p. ix -- Analyst]

TABLE 13

Showing the averages of the different Somatic measurements of some tribes of India

Name of tribes	Kharia	Kol	Iluva	Santal	Munda	Oraon	Hill Marias	Bison Horn Marias	Mal Paharia	Santal	Santal
Locality	Chota Nagpur	U.P.	S. India	Bengal	Chota Nagpur	Chota Nagpur	Bastar State	Bastar State	Bengal	Santal Parganas	Santal Parganas
Number of subjects Measured by	78 Risley	32 Risley	50 Guha	100 Risley	100 Risley	100 Risley	100 Roy	50 Roy	100 Risley	100 Chatterji & Kumar	100 Biswas
Stature	1601.0	1650.0	1594.90 ±4.33	1614.0	1589.0	1621.0	1627.0	1617.0	1577.0	2604.78 ±6.74	1593.0 ±3.40
Max. Head Length	184.4	183.1	190.02 ±0.48	184.8	185.9	184.6	185.39	181.38	183.4	185.27 ±0.65	185.0 ±0.06
Max. Head Breadth	137.4	132.6	139.34 ±0.50	140.7	138.6	139.3	138.71	138.46	139.1	138.35 ±0.54	137.0 ±0.05

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Name of tribes	Kharia	Kol	Iluva	Santal	Munda	[illegible]	Hill Marias	Bison Horn Marias	Mal Paharia	Santal	Santal
Locality	Chota Nagpur	U.P.	S. India	Bengal	Chota Nagpur	Chota Nagpur	Bastar State	Bastar State	Bengal	Santal Parganas	Santal Parganas
Auricular height	129.8	127.2	119.62 ±0.64	128.5	129.2	129.2	119.93	117.14	126.5	123.37 ±0.37	129.0 ±0.10
Min. Frontal breadth	101.0	97.1	101.22 ±0.36	102.1	101.5	101.9	101.66	100.10	100.5	101.27 ±0.60	100.2 ±0.12
Max. Bizygomatic breadth	130.8	130.8	128.76 ±0.43	132.5	130.7	130.4	132.17	130.68	130.9	130.64 ±0.32	130.0 ±0.50
Bigonial Breadth	...	...	96.64 ±0.55	...	...	...	88.03	86.50	...	97.29 ±0.43	92.0 ±0.60
Inter Orbital	...	...	31.22 ±0.26	...	...	...	32.23	30.44	...	30.99 ±0.13	...
Orbitonasal Arc	...	...	111.22 ±0.50	...	...	...	110.05	107.92	...	112.13 ±0.43	113.0 ±0.60
Nasal Height	45.3	44.0	49.38 ±0.31	45.7	44.7	46.2	48.07	49.04	44.1	48.30 ±0.36	48.0 ±0.40

Nasal Breadth	40.1	36.2	36.98 ±0.22	40.6	40.2	39.8	39.68	30.84	41.0	37.80 ±0.20	37.9 ±0.30
Nasal depth	...	...	23.32 ±0.21	...	...	...	16.33	15.86	...	16.30 ±0.13	...
Superior Facial Height	...	...	64.26 ±0.35	...	...	...	65.60	63.84	...	58.23 ±0.41	71.0 ±0.50
Total Facial Height	...	...	115.44 ±0.60	...	...	..	113.22	110.40	...	111.70 ±0.61	113.0 ±0.50
Horizontal circumference of Head	...	...	534.44 ±1.46	...	...	...	...	...	...	534.10 ±0.12	...
Transverse Arc	...	...	331.46 ±0.91	...	...	...	...	...	...	326.00 ±0.12	...
Saggital Arc	...	...	307.12 ±1.13	...	...	...	...	...	...	334.60 ±0.13	...

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Finger Prints : The data collected on the Santals included impressions of all the fingers of 21 male individuals. The analysis of the data is given below :

The following table shows the frequencies of the three patterns, in percentages, for both the hands

Frequencies of finger-print patterns

TABLE I

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Digit	Hands	*Pattern types* LOOP Whorls	Ulnar	Radial	Total	Arch
I	R	71.42	23.80	4.76	28.56	...
	L	57.14	42.85	...	42.85	...
	R+L	64.28	33.33	2.38	35.71	...
II	R	42.85	42.85	9.52	52.37	4.76
	L	42.85	38.09	19.04	57.13	...
	R+L	42.85	40.47	14.28	54.75	2.38
III	R	38.09	61.90	—	61.90	...
	L	47.61	52.38	...	52.38	...
	R+L	42.85	57.14	...	57.14	—
IV	R	71.42	28.57	...	28.57	...
	L	71.42	28.57	...	28.57	...
	R+L	71.42	28.57	...	28.57	...
V	R	33.33	66.66	...	66.66	...
	L	28.57	71.42	...	71.42	...
	R+L	30.95	69.04	...	69.04	...
ALL DIGITS	R	51.42	44.76	3.86	47.62	0.95
	L	49.52	46.66	3.81	50.47	...
	R+L	50.47	45.71	3.34	49.05	0.47

The first fact that comes to notice when one observes this table is the paucity of arches. Only the second digit displays arches, and that even, only on the right hand. Whorls occur in comparatively high frequency on the I and IV digits, and the striking factor about loops is that no radial loops are observed on the III, IV and V digits of both hands.

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141 Summing up the frequencies for all patterns on all the digits, whorls (50.47%) and Ulnar patterns (45.71%) and most frequent, radial loops (3.34%) less frequent, and arches negligible (0.47%).

TABLE II

142 **Percentages of Whorls, Loops and Arches in different races**

Race	Whorls	Loops	Arches	Author
Bushmen	15.1	68.5	16.4	Weninger '36
Hottentot	18.6	76.3	5.1	Fleischhacker '34
Norwegians	25.6	66.9	7.4	Bonnevie
English	26.0	67.3	6.5	Galton
Germans	30.3	62.7	7.0	Lublien '40
Spaniards	30.3	63.2	6.5	Oloriz '08
Italians	36.4	58.4	4.7	Falco
Ainus	34.6	62.2	3.3	Koya '37
Rajputs(Jaunsar)	39.2	53.6	7.1	Monga*
Oraons	36.6	57.3	6.1	Verma
Koltas (Jaunsar)	41.0	53.6	5.4	Deol*
Rajputs (Kulu)	48.3	50.6	1.0	Datta*
Rajis	46.3	52.5	1.0	Tiwari
Bhotias	50.7	46.9	2.2	Tiwari
Santals	50.47	49.05	0.47	Biswas
Javanese	34.6	64.1	1.3	Abel '40
Formosans	36.4	58.9	4.8	Kubo '28
Red Indians	42.0	55.5	2.3	Cummins '30
Eskimos	72.2	26.9	0.8	Abel
Sumatrans	45.1	53.1	1.7	Kleiweg de Zwaan
Japanese	45.1	52.7	1.8	Kubo
Koreans	48.1	49.8	2.1	Tanaka
Chinese	50.6	47.6	1.4	Kubo '18
Australians	77.6	22.1	0.2	Cummins and Setzler

From the above table, a clear difference is evident in the frequency of the appearance of three basic

*Unpublished data